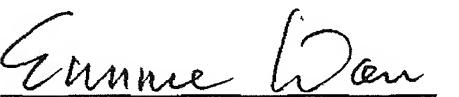


### CERTIFICATION OF TRANSLATION

I, Eun-mee Won, an employee of Y.P. LEE, MOCK & PARTNERS of Koryo Bldg., 1575-1 Seocho-dong, Seocho-gu, Seoul, Republic of Korea, hereby declare under penalty of perjury that I understand the Korean language and the English language; that I am fully capable of translating from Korean to English and vice versa; and that, to the best of my knowledge and belief, the statement in the English language in the attached translation of Korean Patent Application No. 10-2003-0012868 consisting of 34 pages, have the same meanings as the statements in the Korean language in the original document, a copy of which I have examined.

Signed this 22nd day of August 2007

A handwritten signature in black ink, appearing to read "Eun-mee Won".

## A B S T R A C T

### [Abstract of the Disclosure]

Provided are a write-once disc, an apparatus for recording information thereon, and a method of reducing access time thereto. The write-once disc has a single record layer in which a lead-in area, a data area, and a lead-out area are sequentially arranged. The write-once disc includes at least one update area located in at least one of the lead-in area, the data area, and the lead-out area and in which updated predetermined information is recorded; and an access information area located in at least one of the lead-in area and the lead-out area and in which location information regarding information, which is lastly updated and recorded in the at least one update area, is recorded at predetermined intervals of time. Accordingly, it is possible to reduce an access time for reading information updated in the write-once disc on which predetermined information is updated and recorded on a new location.

15

### [Representative Drawing]

FIG. 3

## S P E C I F I C A T I O N

[Title of the Invention]

Recording Apparatus for Write Once Disc, Method for Reducing Access Time to Write

5 Once Disc and Disc Thereof

[Brief Description of the Drawings]

FIG. 1 is a block diagram of a recording apparatus according to a preferred embodiment of the present invention.

10 FIG. 2 illustrates structures of a write-once disc 100 according to preferred embodiments of the present invention.

FIG. 3 illustrates a data structure of a write-once disc 100 with an access information area and an update area, according to a preferred embodiment of the present invention.

15 FIG. 4 is a reference diagram illustrating recording of data on a write-once disc 100, according to a preferred embodiment of the present invention.

FIGS. 5A through 5D are reference diagrams respectively illustrating location information recorded in an access information area of a write-once disc, according to preferred embodiments of the present invention.

20 FIG. 6 illustrates a data structure of location information AA #i illustrated in FIGS. 4 and 5A through 5D.

FIG. 7 is a reference diagram illustrating recording of data on a write-once disc 100, according to another embodiment of the present invention.

25 FIG. 8 illustrates a data structure of information A #i recorded in an update area A of FIG. 7.

FIG. 9 illustrates a data structure of a write-once disc 100 according to a preferred embodiment of the present invention.

30 FIG. 10 illustrates detailed diagrams for explaining recording of data in a user data area and a spare area of a write-once disc, according to a preferred embodiment of the present invention.

[Detailed Description of the Invention]

[Object of the Invention]

[Technical Field of the Invention and Related Art Prior to the Invention]

The present invention relates to recording information on or reproducing information from a write-once disc, and more particularly, to a write-once disc, an apparatus for recording information thereon, and a method of reducing access time thereto.

5       Unlike a rewritable disc, it is impossible to rewrite data to a portion of a write-once disc where data has already been recorded. That is, once the data is recorded on the write-once disc, it is impossible to delete the data and record new data thereon. Accordingly, a new portion of the write-once disc must be allotted to update the already recorded data.

10      In general, since only lastly updated information on a disc is available, a recording or reproducing apparatus first scans the disc to detect the lastly updated information. The more information to be updated, the longer time is for scanning the disc to obtain recent information from the disc. In particular, this problem becomes more serious for a write-once disc, since whenever information is updated, the updated 15 information is recorded at different portions of an area of the write-once disc unlike a rewritable disc. If the size of the area where information is updated is reduced to lessen a disc scanning time, desired information can be fast detected but a number of times of updating information is limited.

20      [Technical Goal of the Invention]

The present invention provides a write-once disc in which specific information is updated and recorded at a new location, and a method of recording information on the write-once disc in a data structure such that a disc access time for reading the updated information is reduced.

25      [Structure of the Invention]

According to an aspect of the present invention, there is provided a write-once disc with a single record layer, in which a lead-in area, a data area, and a lead-out area are sequentially arranged, the write-once disc including at least one update area 30 located in at least one of the lead-in area, the data area, and the lead-out area and in which updated predetermined information is recorded; and an access information area located in at least one of the lead-in area and the lead-out area and in which location information regarding information, which is lastly updated and recorded in the at least one update area, is recorded per predetermined period.

According to another aspect of the present invention, there is provided a write-once disc having a first record layer in which a lead-in area, a data area, and a lead-out area are sequentially arranged, and a second record layer in which an outer area, a data area and a lead-out area are sequentially arranged, the write-once disc including at least one update area located in at least one of the lead-in area, the data area, the lead-out area, and the outer area and in which predetermined is updated and sequentially recorded; and an access information area located in at least one of the lead-in area, the lead-out area, and the outer area and in which location information regarding information, which is lastly updated and recorded in the update areas, is recorded per predetermined period.

According to another aspect of the present invention, there is provided a write-once disc with a single record layer, in which a lead-in area, a data area, and a lead-out area are sequentially arranged, the write-once disc including a plurality of update areas located in at least one of the lead-in area and the lead-out area and in which updated predetermined information is updated and sequentially recorded; and an access information area located in at least one of the lead-in area and the lead-out area and in which location information regarding information, which is lastly updated and recorded in the update areas, is recorded per predetermined period. The location information regarding information, which is lastly updated and recorded in at least one of the update areas, is recorded in at least one of the other update areas.

According to another aspect of the present invention, there is provided a write-once disc having a first record layer in which a lead-in area, a data area, and a lead-out area are sequentially arranged, and a second record layer in which an outer area, a data area and a lead-out area are sequentially arranged, the write-once disc including a plurality of update areas located in at least one of the lead-in area, the lead-out area, and the outer area and in which predetermined is updated and sequentially recorded; and an access information area located in at least one of the lead-in area, the lead-out area, and the outer area and in which location information regarding information, which is lastly updated and recorded in the update areas, is recorded per predetermined period. The location information regarding information, which is lastly updated and recorded in at least one of the update areas, is recorded in at least one of the other update areas.

The location information recorded in the access information area may be recorded whenever a recording operation is completed a predetermined number of

times or whenever information is stored in a specific number of blocks of the update areas.

The location information recorded in the access information area may be repeatedly recorded several times, sequentially recorded starting from the start or the 5 end of the access information area, or recorded in at least two sub regions of a plurality of sub areas of the access information area.

The location information recorded in the update area may be recorded for each recording operation.

According to another aspect of the present invention, there is provided a method 10 of reducing an access time for accessing a write-once disc with a single record layer, in which a lead-in area, a data area, and a lead-out area are sequentially arranged, the method including (a) sequentially recording updated predetermined information in at least one update area present in at least one of the lead-in area and the lead-out area; and (c) recording location information regarding information, which is lastly updated in 15 the update area, in an access information area present in at least one of the lead-in area, the data area, and the lead-out area per predetermined period.

According to another aspect of the present invention, there is provided a method 20 of reducing access time for accessing a write-once disc with a single record layer, in which a lead-in area, a data area, and a lead-out area are sequentially arranged, the method comprising (a) sequentially recording updated predetermined information in a plurality of update areas present in at least one of the lead-in area and the lead-out area; (b) recording location information regarding information, which is lastly updated in one of the update areas; and (c) recording location information regarding the lastly 25 updated information in an access information area present in at least one of the lead-in area and the lead-out area for each predetermined period.

According to another aspect of the present invention, there is provided a method 30 of reducing access time for accessing a write-once disc with a first record layer in which a lead-in area, a data area, and a lead-out area are sequentially arranged, and a second record layer in which an outer area, a data area, and a lead-out area are sequentially arranged, the method comprising (a) sequentially recording updated predetermined information in at least one update area present in at least one of the lead-in area, the lead-out area, and the outer area; and (c) sequentially recording location information regarding information, which is lastly updated in the update area in an access information area present in at least one of the lead-in area, the lead-out area, 35

and the outer area.

According to another aspect of the present invention, there is provided a method of reducing access time for accessing a write-once disc with a first record layer in which a lead-in area, a data area, and a lead-out area are sequentially arranged, and a second record layer in which an outer area, a data area, and a lead-out area are sequentially arranged, the method comprising (a) sequentially recording updated predetermined information in a plurality of update areas present in at least one of the lead-in area, the lead-out area, and the outer area; (b) recording location information regarding information, which is lastly updated in one of the update areas; and (c) recording location information regarding the lastly updated information in an access information area present in at least one of the lead-in area, the lead-out area, and the outer area per predetermined period.

(c) may be performed whenever a recording operation is completed a predetermined number of times or whenever information is stored in a specific number of blocks of the update areas.

According to another aspect of the present invention, there is provided an apparatus for recording information on a write-once disc with a single record layer in which a lead-in area, a data area, and a lead-out area are sequentially arranged, the apparatus comprising a recording/reading unit that records information on or reads data from the write-once disc; and a controller that controls the recording/reading unit to sequentially record updated predetermined information in at least one update area present in the lead-in area and the lead-out area, and record location information regarding information, which is lastly updated in the at least one update area, in an access information area present in the lead-in area and the lead-out area per predetermined period.

According to another aspect of the present invention, there is provided an apparatus for recording information on a write-once disc with a single record layer in which a lead-in area, a data area, and a lead-out area are sequentially arranged, the apparatus comprising a recording/reading unit that records information on or reads data from the write-once disc; and a controller that controls the recording/reading unit to sequentially record updated predetermined information in a plurality of update areas present in at least one of the lead-in area and the lead-out area, record location information regarding information, which is lastly updated in the at least one of the update areas, in one of the update areas, and record location information regarding

information lastly updated in the updated area in an access information area present in at least one of the lead-in area and the lead-out area per predetermined period.

According to another aspect of the present invention, there is provided an apparatus for recording information on a write-once disc with a first record layer in which a lead-in area, a data area, and a lead-out area are sequentially arranged and a second record layer in which an outer area, a data area, and a lead-out area are sequentially arranged, the apparatus comprising a recording/reading unit that records information on or reads data from the write-once disc; and a controller that controls the recording/reading unit to sequentially record updated predetermined information in at least one update area present in at least one of the lead-in area, the lead-out area, and the outer area, and record location information regarding information, which is lastly updated in the at least one update area, in an access information area present in the lead-in area, the lead-out area, and the outer area for each predetermined period.

According to another aspect of the present invention, there is provided an apparatus for recording information on a write-once disc with a first record layer in which a lead-in area, a data area, and a lead-out area are sequentially arranged and a second record layer in which an outer area, a data area, and a lead-out area are sequentially arranged, the apparatus comprising a recording/reading unit that records information on or reads data from the write-once disc; and a controller that controls the recording/reading unit to sequentially record updated predetermined information in a plurality of update areas present in at least one of the lead-in area, the lead-out area, and the outer area, record location information regarding information, which is lastly updated in the at least one of the update areas, in one of the update areas, and record location information regarding the lastly updated information in an access information area present in at least one of the lead-in area, the lead-out, and the outer area per predetermined period.

The controller may control the recording/reading unit to record the location information in the access information area whenever a recording operation is completed a predetermined number of times or whenever information is stored in a specific number of blocks of the update area.

Also, the controller may control the recording/reading unit to record updated information in the update area for every recording operation.

Hereinafter, exemplary embodiments of the present invention will be described in greater detail.

FIG. 1 is a block diagram of a recording apparatus according to a preferred embodiment of the present invention. Referring to FIG. 1, the recording apparatus includes a recording/reading unit 1, a controller 2, and a memory 3. The recording/reading unit 1 records data on a disc 100, which is an information storage medium according to a preferred embodiment of the present invention, and reads back the data from the disc 100 to verify the accuracy of the recorded data. The controller 2 controls the recording/reading unit 1 to record data in a data structure according to the present invention. More specifically, the controller 2 controls the recording/reading unit 1 to sequentially record updated information in at least one update area of the disc 100, and record location information, which specifies a recording position of lastly updated information in the update area, in an access information area of the disc 100 for a predetermined period. In this embodiment, information is recorded in the update area in recording units. The location information is recorded in the access information area whenever a predetermined number of recording operations end or a predetermined number of logical or physical recording blocks of the update area are filled with data. Further, if the disc 100 includes the plurality of update areas, the controller 2 controls the recording/reading unit 1 to record location information, which specifies a recording position of lastly updated information in at least one update area, in the access information area. For disc finalization, the controller 2 controls the recording/reading unit to record the location information regarding information, which is last recorded in the update area, in the access information area.

Here, the recording operation is an operation unit determined according to a user's intention or a recording work to be performed. According to this embodiment, a recording operation indicates a process in which the disc 100 is loaded into the recording apparatus, data is recorded on the disc 100, and the disc 100 is taken out from the recording apparatus. When a user presses the eject button (not shown) of the recording apparatus in order to remove the disc 100 after recording of data, the controller 2 expects the recording operation to be terminated.

In particular, the controller 2 tests recording conditions to adjust a laser power in the recording/reading unit 1, controls the recording/reading unit to record data based on the test result, and performs disc defect management. More specifically, to adjust the laser power, the controller 2 test recording conditions in at least one logical or physical block of a test area, where recording conditions are measured, in recording

operation units. The test area is included in the update area of the disc 100. Accordingly, it is required to detect a position of the test area where recording conditions will be tested next time. Data recorded for test is recorded and updated in the test area. Also, for disc defect management, the controller 2 uses a 5 verify-after-write method in which data is recorded on the disc 100 in predetermined units of data and the accuracy of the recorded data is verified to detect if an area of the disc 100 has a defect. In other words, the controller 2 controls the recording/reading unit 1 to record user data on the disc 100 in units of recording operations and verifies the recorded user data to detect an area of the disc 100 in which a defect exists.

10 Thereafter, the controller 2 creates information indicating the position of the area with the defect and stores the created information in the memory 3. When the stored information reaches a predetermined amount, the controller 2 controls the recording/reading unit 1 to record the stored information as temporary defect information in an update area, i.e., a temporary defect management area (TDMA), of 15 the disc 100. Next, the controller 2 controls the recording/reading unit 1 to further record temporary defect management information for managing the temporary defect information in the TDMA. During each recording operation, data is recorded and verified at least once; in general, data is recorded and verified several times. Defect information obtained using the verify-after-write method is temporarily stored as 20 temporary defect information in the memory 3. When the recording operation ends, the controller 2 controls the recording/reading unit 1 to rewrite the temporary defect information, which is stored in the memory 3, to a defect management area (DMA) of the disc 100.

When the recording of data is completed, i.e., additional data will not be 25 recorded on the disc 100 (the disc 100 needs to be finalized), and the controller 2 controls the recording/reading unit 1 to rewrite the temporary defect information and the temporary defect management information, which are stored in the TDMA, to the DMA.

FIGS. 2A and 2B illustrate structures of the disc 100 of FIG. 1, according to 30 preferred embodiments of the present invention. FIG. 2A illustrates in detail a disc 100 having a single record layer  $L0$  (single record layer disc). The disc 100 includes a lead-in area, a data area, and a lead-out area. The lead-in area is located in an inner part of the disc 100 and the lead-out area is located in an outer part of the disc 100. The data area is present between the lead-in area and the lead-out area and divided

into a user data area and a spare area. The user data area is an area where user data is recorded, and the spare area is a replacement area for a user data area having a defect, serving to compensate for loss in the recording area due to the defect.

FIG. 2B illustrates a disc 100 having two record layers  $L_0$  and  $L_1$  (double record layer disc). A lead-in area, a data area, and an outer area are sequentially formed from the inner part of the first record layer  $L_0$  to its outer part. Also, an outer area, a data area, and a lead-out area are sequentially formed from the outer part of the second record layer  $L_1$  to its inner part. Unlike the single record layer disc of FIG. 2B, the lead-out area is present in the inner part of the disc 100 of FIG. 2B. That is, the disc 100 of FIG. 2B has an opposite track path (OTP) in which data is recorded starting from the lead-in area of the first record layer  $L_0$  toward its outer area and continuing from the outer area of the second record layer  $L_1$  to its lead-out area. The spare area is allotted to each of the record layers  $L_0$  and  $L_1$ .

In this embodiment, the spare areas are present between the lead-in area and the user data area and between the user data area and the outer area. However, if necessary, a portion of the user data area may be used as another spare area, that is, more than one spare area may be present between the lead-in area and the lead-out area.

FIG. 3 is a diagram illustrating a disc 100 according to an embodiment of the present invention. Referring to FIG. 3, if the disc 100 is a single record layer disc, the access information area is present in at least one of the lead-in area and the lead-out area. If the disc 100 is a double record layer disc, the access information area is present in at least one of the lead-in area, the lead-out area, and the outer area. A plurality of the access information areas may be formed in separate areas or be formed separately in the same area.

Further, when the disc 100 is a single record layer, at least one update area is present in at least one of the lead-in area and the lead-out area. When the disc 100 is a double record layer, at least one update area is present in at least one of the lead-in area, the lead-out area, and the outer area. FIG. 3 illustrates two update areas A and B in which information to be updated is respectively recorded. In this embodiment, predetermined information is updated and recorded in the update areas A and B in recording operation units. A period of updating information may be changed depending on characteristics of information to be recorded or a user's desire. In the access information area, location information regarding of respective information that is

lastly updated in the update areas  $A$  and  $B$  is recorded per predetermined period. In this embodiment, the location information is recorded in a predetermined number of recording operation units or is recorded whenever a predetermined number of logical or physical blocks are filled with information. If necessary, only location information, 5 which specifies recording locations of information updated in parts of a plurality of update areas, may be recorded in the access information area.

For access time, a size of a block, which is a basic unit for error correcting code (ECC), of the update area  $A$  is preferably small. During a write operation, location 10 information regarding the location of information last recorded in at least another update area is recorded whenever information recorded in the update area  $A$  is recorded. When a total number of recording operations is expected to be small according to characteristics of data to be recorded or a user environment, a period of 15 updating the location information recorded in the access information area is determined to be short. Otherwise, the period may be determined to be long. An instant of time when the location information recorded in the access information area is updated, may also be differently determined.

During a read operation, information for accessing information recorded in the updated areas is obtained by reading location information last recorded in the access information area while scanning the access information area starting from a start 20 thereof. For disc finalization, location information regarding information last recorded in the respective updated areas is recorded in the access information area.

FIG. 4 illustrates a method of recording information on the disc 100, according to a preferred embodiment of the present invention. Referring to FIG. 4, predetermined 25 information is updated  $n$  times and sequentially recorded as  $A\#1, A\#2, \dots, A\#n$  in an update area  $A$ , and predetermined information is updated  $n$  times and sequentially recorded as  $B\#1, B\#2, \dots, B\#n$  in an update area  $B$ . Next, location information  $AA\#1$  regarding the information  $A\#n$  lastly updated and recorded in the update area  $A$  and the information  $B\#n$  lastly updated and recorded in the update area  $B$  is recorded in an access information area. The location information  $AA\#1$  may specify physical or 30 logical addresses of the information  $A\#n$  and  $B\#n$ . Next, predetermined information is updated  $n$  times and sequentially recorded as  $A\#n+1, A\#n+2, \dots, A\#2n$  in the update area  $A$ , and predetermined information is updated  $n$  times and sequentially recorded as  $B\#n+1, B\#n+2, \dots, B\#2n$  in the update area  $B$ . Similarly, location information  $AA\#2$  is recorded in the access information area. Alternatively, location information  $AA\#1$

recorded in the access information area may include only location information regarding information lastly updated and recorded in the update area *A* or *B*.

FIGS. 5A through 5D illustrate location information recorded in an access information area, according to preferred embodiments of the present invention.

5 Referring to FIG. 5A, the location information is repeatedly recorded in the access information area. More specifically, first location information AA#1 is recorded starting a start of the access information area, so that physical or logical addresses increase. Next, a copy of the first location information AA#1 is recorded. Next, second location information AA#2 is recorded, and then, a copy of the second location information AA#2 is recorded. Recording the same information twice increases the reliability and robustness of information. The number of times of recording the same information may be more than twice and the same information may be recorded using an interleaving method.

10 Referring to FIG. 5B, as compared to FIG. 5A, location information is repeatedly recorded in the access information area but the sequence of recording the location information is not the same. More specifically, first location information AA#1 is recorded starting from an end of the access information area, so that physical or logical addresses decrease. Next, a copy of the first location information AA#1 is recorded, and then, second location information AA#2 is recorded. Next, a copy of the second location information AA#2 is recorded. Recording the same information twice increases the reliability and robustness of information. Similarly, the number of times of recording the same information may be more than twice and the same information may be recorded using an interleaving method.

15 The access information area of FIG. 5C is physically or logically divided into two sub areas. In a first sub area, first location information AA#1 and second location information AA#2 are sequentially recorded, so that physical or logical addresses increase. In a second sub area, a copy of the first location information AA#1 and a copy of the second location information AA#2 are sequentially recorded. Regarding a sequence of recording these information, the first location information AA#1, the copy 20 of the first location information AA#1, the second location information AA#2, and the copy of the second location information AA#2 are sequentially recorded. In this embodiment, the original information and a copy thereof are recorded in different areas, thereby increasing the reliability and robustness of information. Alternatively, the access information area may be divided into three or more sub areas, and location

information may be recorded at least three times.

As compared to FIG. 5C, the access information area of FIG. 5D is physically or logically divided into two sub areas, but the sequence of recording location information is not the same. More specifically, first location information AA#1 and second location information AA#2 are sequentially recorded in a first sub area, so that physical or logical addresses decrease. Also, a copy of the first location information AA#1 and a copy of the second location information AA#2 are sequentially recorded in a second sub area, so that physical or logical addresses decrease. The sequence of recording these information is the same as illustrated in FIG. 5C. That is, the first location information AA#1, the copy of the first location information AA#1, the second location information AA#2, and the copy of the second location information AA#2 are sequentially recorded. The original information and a copy thereof are recorded in different areas, thereby increasing the reliability and robustness of information. Alternatively, the access information area may be divided into three or more sub areas, and location information may be recorded at least three times.

FIG. 6 illustrates a data structure of location information AA#i as shown in FIG. 4 and FIGS. 5A through 5D. Referring to FIG. 6, the location information AA#i contains an identifier, an access pointer to an update area A, and an access pointer to an update area B. The access pointer to the update area A points to a recording position of information lastly updated and recorded in the update area A. The access pointer to the update area B points to a recording position of information lastly updated and recorded in the update area B. For instance, an access pointer indicates a starting address of last recorded information.

FIG. 7 illustrates a method of recording information on the disc 100, according to another embodiment of the present invention. Referring to FIG. 7, as shown in FIG. 4, predetermined information is updated  $n$  times and sequentially recorded as A#1, A#2, ..., A#n in an update area A, and predetermined information is updated  $n$  times and sequentially recorded as B#1, B#2, ..., B#n in an update area B. Next, location information AA#1 regarding information A#n lastly updated and recorded in the update area A and information B#n lastly updated and recorded in the update area B is recorded in an access information area. The location information AA#1 may specify physical or logical addresses of the information A#n and B#n. Next, predetermined information is updated  $n$  times and sequentially recorded as A#n+1, A#n+2, ..., A#2n in the update area A, and predetermined information is updated  $n$  times and sequentially

recorded as  $B\#n+1, B\#n+2, \dots, B\#2n$  in the update area  $B$ . Next, location information AA#2 regarding information  $A\#2n$  lastly updated and recorded in the update area  $A$  and information  $B\#2n$  lastly updated and recorded in the update area  $B$  is recorded in the access information area. Alternatively, location information AA# $i$  recorded in the 5 access information area may include only location information regarding lastly updated information recorded in the update area  $A$  or  $B$ .

The information  $A\#1, A\#2, \dots, A\#n+1, \dots, A\#2n$  further include location information specifying location of lastly updated information recorded in the update area  $B$ . For instance, the location information included in the information  $A\#n+1$ , which is recorded in the update area  $A$ , point to a recording position of the corresponding information  $B\#n+1$  recorded in the update area  $B$ . For this reason, whenever the update area  $B$  is updated, the update area  $A$  must also be updated. For instance, sometimes the information  $A\#1, A\#2, \dots, A\#n+1, \dots, A\#2n$  need to be 10 updated although there is no change therein, only because the information recorded in the update area  $B$  changes. In a worst-case scenario, when instants when updating a plurality of update areas are different from one another, and a recording position of 15 lastly updated information is recorded in the update area  $A$  whenever information recorded in update areas other than the update area  $A$  is updated, a size of the update area  $A$  is required to be the same as or larger than a sum of sizes of the other update areas. To prevent such a problem, instants when updating the other update areas are 20 preferably the same to minimize the size of the update area  $A$ . Also, after recording updated information in the other update areas, the information recorded in the update area  $A$ , which is updated, and location information regarding at least one information recorded in the other update areas are recorded in the update area  $A$ . Information is 25 recorded in the update area  $A$  after completing recording information in the other update areas, since a predetermined recording position of lastly updated information in the other update areas can be changed. When a position of recording lastly updated information in the update area  $B$  has been determined and location information regarding the lastly updated information is recorded in the update area  $A$ , if an ECC 30 error occurs in the update area  $B$  after recording the lastly updated information in the update area  $B$ , a position of the lastly updated information in the update area  $B$  may change.

FIG. 8 illustrates a data structure of information  $A\#i$  recorded in the update area  $A$  of FIG. 7. Referring to FIG. 8, the information  $A\#i$  includes information regarding

itself and a pointer pointing to a location of corresponding information  $B\#i$  recorded in the update area  $B$  of FIG. 7.

FIG. 9 illustrates a structure of the disc 100 of FIG. 1, according to a preferred embodiment of the present invention. For convenience, FIG. 9 illustrates the disc 100 as a single record layer disc. Referring to FIG. 9, a lead-in area of the disc 100 includes an access information area, a defect management area (DMA), a temporary DMA (TDMA), and a recording condition test area. A lead-out area of the disc 100 includes at least one of an access information area, a DMA, a TDMA, and a recording condition test area. That is, the access information area, the DMA, the TDMA, and the recording condition test area may be present in at least one of the lead-in area and the lead-out area. If the disc 100 is a double record layer disc, an access information area, a DMA, a TDMA, and a recording condition test area are included in each of a lead-in area and a lead-out area positioned in an inner part of the disc 100. Also, an access information area, a DMA, a TDMA, and a recording condition test area are included in each of a lead-in area and a lead-out area positioned in an outer part of the disc 100.

Here, the TDMA and the recording condition test area correspond to the update areas  $A$  and  $B$  of FIG. 3, 4, or 7. In the access information area, location information regarding temporary management information updated and recorded in the TDMA, and location information regarding a portion of the recording condition test area where recording conditions are last tested are recorded. The temporary management information includes temporary defect information and temporary defect management information. The location information regarding a portion of the recording condition test area may specify a start address of a portion of the recording condition test area where recording conditions will be tested next time. Alternatively, location information regarding information recorded in the TDMA or the recording condition test area may be selectively recorded in the access information area. In the TDMA, the location information regarding a portion of the recording condition test area where recording conditions are last tested is recorded.

In this embodiment, a recording apparatus tests recording conditions in the recording condition test area for every recording operation, records information on the disc 100 based on the test result, and records temporary management information in the TDMA whenever a recording operation ends. Thus, information recorded in the TDMA and information in the recording condition test area are updated in recording

operation units. Also, location information regarding the recording condition test area is recorded together with the temporary management information in the TDMA.

In general, information regarding a structure of a disc on which disc defect management is performed, whether the disc defect management is performed or not, a 5 location and information regarding a defect, and a size and location of a spare area is recorded in the DMA.

When the disc 100 is loaded into a recording/reading apparatus such as that shown in FIG. 1, the apparatus generally reads data from a lead-in area and/or a lead-out area of the disc 100 to determine how to manage the disc 100 and to record data on or read data from the disc 100. However, if the amount of data recorded in the lead-in area and/or the lead-out area increases, a longer time is for preparing the recording or reproducing of data after the loading of the disc 100. To solve this 10 problem or for other reasons, the present invention adopts temporary defect management information and temporary defect information that are to be recorded in a TDMA. The TDMA is allotted to the lead-in area and/or the lead-out area of a disc, 15 being separated from the DMA. For disc finalization, temporary management information, including temporary defect information and temporary defect management information, which is last recorded in the TDMA, is recorded in the DMA. That is, when additional information will not be recorded, that is, disc finalization is required, 20 only last recorded ones of the temporary defect management information and temporary defect information, which have been updated several times, are rewritten to the DMA. Thus, the recording/reading apparatus can fast read defect management information from the disc 100 just by reading the last recorded defect management information, thereby enabling fast initializing of the disc 100.

In this embodiment, since the disc defect management is performed using linear replacement, the temporary defect information includes information indicating the 25 position of an area of the disc 100 having a defect and information indicating the position of an area of the disc 100 that is replacement for the area having the defect. The temporary defect management information is used to manage the temporary 30 defect information and includes information indicating the position of the disc 100 where the temporary defect information is recorded.

In this embodiment, the temporary defect information and temporary defect management information are recorded every time when a recording operation ends. In the TDMA, information regarding a defect, which occurs in data recorded during

recording operation #1, and information regarding a replacement area are recorded as temporary defect information #1, and information regarding a defect, which occurs in data recorded during recording operation #2, and information regarding a replacement area are recorded as temporary defect information #2. Further, in the TDMA,  
5 management information for managing temporary defect information #1, #2, ... is recorded as temporary defect management information #1, #2, ... The management information specifies recording positions of the temporary defect information #1, #2, ...

When additional data cannot be recorded in the data area or a user does not desire to record additional data therein, i.e., disc finalization is required,  
10 temporary defect information recorded in a temporary defect information area and temporary defect management information recorded in a temporary defect management information area are rewritten to the DMA. For disc finalization, last recorded one of the temporary defect information #1, #2, ..., #i is read and rewritten to the DMA.

15 FIG. 10 is a detailed reference diagram illustrating recording of data in a user data area A and a spare area B, according to a preferred embodiment of the present invention.

20 Data can be processed in units of sectors or clusters. A sector denotes a minimum unit of data that can be managed in a file system of a computer or in an application, and a cluster denotes a minimum unit of data that can be physically recorded on a disc at once. In general, one or more sectors constitute a cluster.

25 There are two types of sectors: a physical sector and a logical sector. The physical sector is an area on a disc where a sector of data is to be recorded. An address for detecting the physical sector is called a physical sector number (PSN). The logical sector is a unit in which data can be managed in a file system or an application. An address for detecting the logical sector is called a logical sector number (LSN). A disc recording/reading apparatus such as that in FIG. 1 detects the recording position of data on a disc using a PSN. In a computer or an application for recording or 30 reproducing data, the entire data is managed in units of LSNs and the position of data is detected using an LSN. LSNs and PSNs are mapped by a controller of the recording/reading apparatus, based on whether the disc 100 contains a defect and an initial recording position of data.

Referring to FIG. 10, A denotes a user data area and B denotes a spare area in which PSNs are sequentially allocated to a plurality of sectors (not shown). In general,

each LSN corresponds to at least one PSN. However, since LSNs are allocated to non-defective areas, including replacements recorded in the spare area, the correspondence between the PSNs and the LSNs is not maintained when a disc has a defective area, even if the size of a physical sector is the same as that of a logical sector.

In the user data area A, user data is recorded either in a continuous recording mode or a random recording mode. In the continuous recording mode, user data is recorded sequentially and continuously. In the random recording mode, user data is randomly recorded. In the data area A, sections ① through ⑦ denote predetermined units of data in which the verify-after-write method is performed.

When the disc 100 is loaded into the recording/reading apparatus, the apparatus tests recording conditions in a recording condition test area of the disc 100, adjusts a laser power based on the test result, and records information on the disc 100. As described above, once recording conditions are tested in a portion of the recording condition test area, the portion becomes unavailable, and thus, another portion will be used the next time for testing the recording conditions.

The recording apparatus records user data in section ①, returns to the start of section ①, and checks if the user data is appropriately recorded or a defect exists in section ①. If a defect is detected in a portion of section ①, the portion is designated as defect #1. The user data recorded in defect #1 is also recorded on a portion of the spare area B. Here, the portion of the spare area B in which data recorded in defect #1 is rewritten is called replacement #1. Next, the recording apparatus records user data in section ②, returns to the start of section ②, and checks whether the data is properly recorded or a defect exists in section ②. If a defect is detected in a portion of section ②, the portion is designated as defect #2. Likewise, replacement #2 corresponding to defect #2 is formed in the spare area B. Further, defect #3 and replacement #3 are designated in section ③ of the user data area A and the spare area B, respectively. In section ④, a defect does not occur and a defective area is not designated.

The recording apparatus records information regarding defect #1, #2, and #3 occurring in sections ① through ④ as temporary defect information TDFL #1 in a TDMA, when recording operation #1 is expected to end, after the recording and verifying of data to section ④, i.e., when a user presses the eject button of a recording apparatus or recording of user data allocated in a recording operation, is complete.

Also, management information for managing temporary defect information *TDFL* #1 is recorded as temporary defect management information *TDDS* #1 in the TDMA. Also, location information regarding a portion of the recording condition test area in which a next test will be performed is further recorded in the TDMA.

5        When the disc 100 is again loaded, recording operation #2 starts, recording conditions are measured in the recording condition test area, and data is recorded on the disc 100 based on the measuring result. More specifically, during recording operation #2, data is recorded in sections ⑤ through ⑦ and defects #4 and #5 and replacements #4 and #5 are formed in the user data area *A* and the spare area *B*, respectively, as explained for sections ① through ④. If recording operation #2 is expected to end, the recording apparatus records information regarding defects #4 and #5 as temporary defect information *TDFL* #2. Thereafter, management information for managing the temporary defect information *TDFL* #2 is recorded as temporary defect management information *TDDS* #2 in the TDMA. Also, location information regarding a portion of the recording condition test area in which a next test will be performed is further recorded in the TDMA. When a predetermined number of recording operations are performed as described above, location information regarding last recorded temporary management information recorded in the TDMA, and location information regarding a portion of the recording condition test area where recording conditions will be performed, are recorded in an access information area of the disc 100. The temporary management information includes temporary defect information and defect management information.

10      15      20

According to the present invention, an access time for the disc 100 can be reduced as described below.

25      If ECC is performed in block units and a reproduction time of a block is 1, data recording is performed in block units which are also ECC units. When data recording is performed in update areas *A*, *B*, and *C* according to a recording operation and as a result, the amount of information to be updated exceeds a block, the access information area is very helpful. When information to be updated can be recorded within a block, a number of times of performing recording operations is equivalent to a number of blocks used. In this case, it is easy to estimate a recording position of information updated. It is assumed that a result of performing a recording operation once reveals that updated information can be recorded within a block and location information is recorded in the access information area whenever information stored in

30

an update area is updated thirty times. In this case, when a number of times that the update area A is updated, i.e., a number of times of performing a recording operation, is 299, an access time for accessing the update area A to update it with latest information varies depending on whether the access information area is present or not, as follows:

- when the access information area is present:  $299/30 + 299\%30+1$   
 $=9+29+1=39$  (% denotes a modular operation)
- when the access information area is not present: 299

In conclusion, before performing the recording operating thirty times, the access time for accessing the update area A does not vary depending on whether the access information area is present. However, when the recording operating is performed thirty times or more, a time required to reproduce information from twenty-nine blocks can be saved whenever the recording operation is further performed thirty times.

When a number of times that the recording operation can be performed is 300 or 500, the following tables show the longest access time and an average access time for obtaining information lastly updated in the update area A and the size of the access information area when updating of the access information area is needed.

20 [Table 1]

When updating is needed	0	10	20	30
Longest access time	300	39	34	39
Average access time	150.5	20.07	17.49	19.94
TASAA size (block)	0	30	15	10

<when a maximum number of times that the recording operation is performed is 300>

[Table 1]

When updating is needed	0	10	20	30
Longest access time	500	59	44	45
Average access time	250.5	30.08	22.51	23.15
TASAA size (block)	0	50	25	17

<when a maximum number of times that the recording operation is performed is 600>

25 The time unit used in Tables 1 and 2 indicates the amount of time required to reproduce information stored in a block. From Tables 1 and 2, it is noted that intervals of time that the access information area is recorded in the access information area are

not always preferable increased. Accordingly, it is required to determine a proper number of times that the recording operation is performed, i.e., a point of time when information is updated, through experiments and in consideration other conditions. For example, the longest access time, the average access time, and the size of the 5 access information area may be considered to determine an opportune point of time when information is updated.

[Effect of the Invention]

As described above, the present invention provides a write-once disc in which 10 predetermined information is updated and recorded at a new position, and a method of recording information in the write-once disc in a data structure in order to read the updated information while minimizing an access time for accessing the write-once disc.

What is claimed:

1. A write-once disc with a single record layer in which a lead-in area, a data area, and a lead-out area are sequentially arranged, the write-once disc comprising:

5 at least one update area located in at least one of the lead-in area, the data area, and the lead-out area and in which updated predetermined information is recorded; and

10 an access information area located in at least one of the lead-in area and the lead-out area and in which location information regarding information, which is lastly updated and recorded in the at least one update area, is recorded per predetermined period.

2. A write-once disc having a first record layer in which a lead-in area, a data area, and a lead-out area are sequentially arranged, and a second record layer in which an outer area, a data area and a lead-out area are sequentially arranged, the write-once disc comprising:

15 at least one update area located in at least one of the lead-in area, the data area, the lead-out area, and the outer area and in which predetermined is updated and sequentially recorded; and

20 an access information area located in at least one of the lead-in area, the lead-out area, and the outer area and in which location information regarding information, which is lastly updated and recorded in the update areas, is recorded per predetermined period.

3. A write-once disc with a single record layer in which a lead-in area, a data area, and a lead-out area are sequentially arranged, the write-once disc comprising:

25 a plurality of update areas located in at least one of the lead-in area and the lead-out area and in which updated predetermined information is updated and sequentially recorded; and

30 an access information area located in at least one of the lead-in area and the lead-out area and in which location information regarding information, which is lastly updated and recorded in the update areas, is recorded per predetermined period.

The location information regarding information, which is lastly updated and recorded in at least one of the update areas, is recorded in at least one of the other update areas.

4. A write-once disc having a first record layer in which a lead-in area, a data area, and a lead-out area are sequentially arranged, and a second record layer in which an outer area, a data area and a lead-out area are sequentially arranged, the write-once disc comprising:

5 a plurality of update areas located in at least one of the lead-in area, the lead-out area, and the outer area and in which predetermined is updated and sequentially recorded; and

10 an access information area located in at least one of the lead-in area, the lead-out area, and the outer area and in which location information regarding information, which is lastly updated and recorded in the update areas, is recorded per predetermined period.

15 5. The disc of one of claims 1 through 4, wherein the location information is recorded in the access information area whenever a predetermined number of recording operations end.

20 6. The disc of one of claims 1 through 4, wherein the location information is recorded in the access information area whenever a predetermined number of blocks of the at least one update area are filled with information.

25 7. The disc of one of claims 1 through 4, wherein the location information is repeatedly recorded in the access information area several times.

25 8. The disc of one of claims 1 through 4, wherein the location information is sequentially recorded in the access information area starting from the start of the access information area.

30 9. The disc of one of claims 1 through 4, wherein the location information is sequentially recorded in the access information area starting from the end of the access information area.

10. The disc of one of claims 1 through 4, wherein the location information is recorded in at least two sub areas of a plurality of sub areas of the access information area.

11. The disc of claim 3 or 4, wherein the location information is recorded in the update area for each recording operation.

5 12. A method of reducing an access time for accessing a write-once disc with a single record layer, in which a lead-in area, a data area, and a lead-out area are sequentially arranged, the method comprising:

(a) sequentially recording updated predetermined information in at least one update area present in at least one of the lead-in area and the lead-out area; and

10 (c) recording location information regarding information, which is lastly updated in the update area, in an access information area present in at least one of the lead-in area, the data area, and the lead-out area per predetermined period.

15 13. A method of reducing access time for accessing a write-once disc with a single record layer, in which a lead-in area, a data area, and a lead-out area are sequentially arranged, the method comprising:

(a) sequentially recording updated predetermined information in a plurality of update areas present in at least one of the lead-in area and the lead-out area;

(b) recording location information regarding information, which is lastly updated in one of the update areas; and

(c) recording location information regarding the lastly updated information in an access information area present in at least one of the lead-in area and the lead-out area for each predetermined period.

25 14. A method of reducing access time for accessing a write-once disc with a first record layer in which a lead-in area, a data area, and a lead-out area are sequentially arranged, and a second record layer in which an outer area, a data area, and a lead-out area are sequentially arranged, the method comprising:

(a) sequentially recording updated predetermined information in at least one update area present in at least one of the lead-in area, the lead-out area, and the outer area; and

(c) sequentially recording location information regarding information, which is lastly updated in the update area in an access information area present in at least one of the lead-in area, the lead-out area, and the outer area.

15. A method of reducing access time for accessing a write-once disc with a first record layer in which a lead-in area, a data area, and a lead-out area are sequentially arranged, and a second record layer in which an outer area, a data area, and a lead-out area are sequentially arranged, the method comprising:

5 (a) sequentially recording updated predetermined information in a plurality of update areas present in at least one of the lead-in area, the lead-out area, and the outer area;

(b) recording location information regarding information, which is lastly updated in one of the update areas; and

10 (c) recording location information regarding the lastly updated information in an access information area present in at least one of the lead-in area, the lead-out area, and the outer area per predetermined period.

16. The method of one of claims 12 through 15, wherein (c) is performed whenever a predetermined number of recording operations end.

17. The method of one of claims 12 through 15, wherein (c) is performed whenever a predetermined number of blocks of the update area are filled with data.

20 18. The method of one of claims 12 through 15, wherein during (c), the location information is repeatedly recorded in the access information area several times.

25 19. The method of claim 12 or 15, wherein during (c), the location information is sequentially recorded in the access information area starting from the start of the access information area.

30 20. The method of claim 12 or 15, wherein during (c), the location information is sequentially recorded in the access information area starting from the end of the access information area.

21. The method of claim 12 or 15, wherein during (c), the location information is recorded in at least two sub areas of a plurality of sub areas of the access information area.

22. The method of claim 14 or 15, wherein (b) is performed for each recording operation.

5 23. An apparatus for recording information on a write-once disc with a single record layer in which a lead-in area, a data area, and a lead-out area are sequentially arranged, the apparatus comprising:

a recording/reading unit that records information on or reads data from the write-once disc; and

10 a controller that controls the recording/reading unit to sequentially record updated predetermined information in at least one update area present in the lead-in area and the lead-out area, and record location information regarding information, which is lastly updated in the at least one update area, in an access information area present in the lead-in area and the lead-out area per predetermined period.

15 24. An apparatus for recording information on a write-once disc with a single record layer in which a lead-in area, a data area, and a lead-out area are sequentially arranged, the apparatus comprising:

a recording/reading unit that records information on or reads data from the write-once disc; and

20 a controller that controls the recording/reading unit to sequentially record updated predetermined information in a plurality of update areas present in at least one of the lead-in area and the lead-out area, record location information regarding information, which is lastly updated in the at least one of the update areas, in one of the update areas, and record location information regarding information lastly updated in the updated area in an access information area present in at least one of the lead-in area and the lead-out area per predetermined period.

25. An apparatus for recording information on a write-once disc with a first record layer in which a lead-in area, a data area, and a lead-out area are sequentially arranged and a second record layer in which an outer area, a data area, and a lead-out area are sequentially arranged, the apparatus comprising:

a recording/reading unit that records information on or reads data from the write-once disc; and

5 a controller that controls the recording/reading unit to sequentially record updated predetermined information in at least one update area present in at least one of the lead-in area, the lead-out area, and the outer area, and record location information regarding information, which is lastly updated in the at least one update area, in an access information area present in the lead-in area, the lead-out area, and the outer area for each predetermined period.

10 26. An apparatus for recording information on a write-once disc with a first record layer in which a lead-in area, a data area, and a lead-out area are sequentially arranged and a second record layer in which an outer area, a data area, and a lead-out area are sequentially arranged, the apparatus comprising:

15 a recording/reading unit that records information on or reads data from the write-once disc; and

20 a controller that controls the recording/reading unit to sequentially record updated predetermined information in a plurality of update areas present in at least one of the lead-in area, the lead-out area, and the outer area, record location information regarding information, which is lastly updated in the at least one of the update areas, in one of the update areas, and record location information regarding the lastly updated information in an access information area present in at least one of the lead-in area, the lead-out, and the outer area per predetermined period.

25 27. The apparatus of one of claims 23 through 26, wherein the controller controls the recording/reading unit to record the location information in the access information area whenever a predetermined number of recording operations end.

30 28. The apparatus of one of claims 23 through 26, wherein the controller controls the recording/reading unit to record the location information in the access information area whenever a predetermined number of blocks of the update area are filled with information.

29. The apparatus of claim 21 or 22, wherein the controller controls the recording/reading unit to record the predetermined information updated in the update area for each recording operation.

FIG. 1

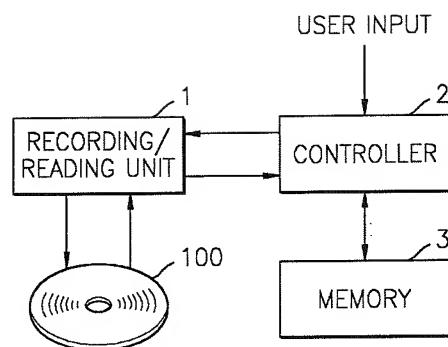


FIG. 2A

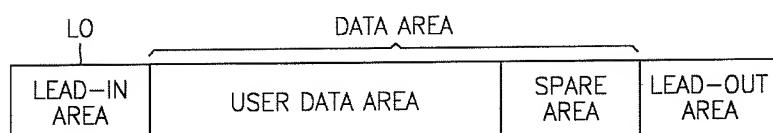


FIG. 2B

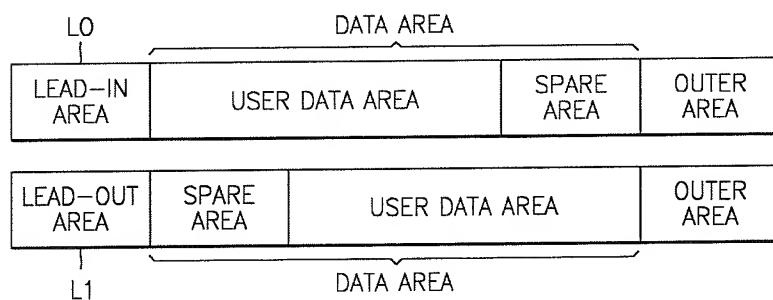


FIG. 3

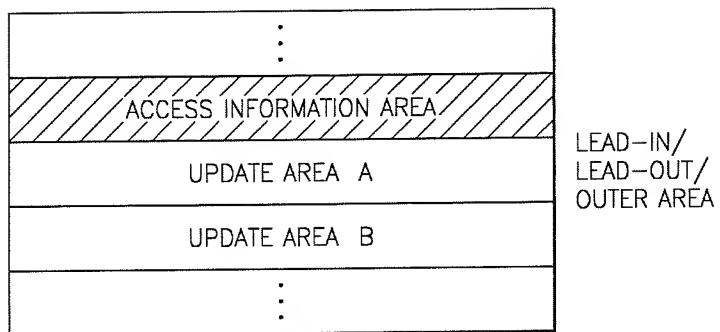


FIG. 4

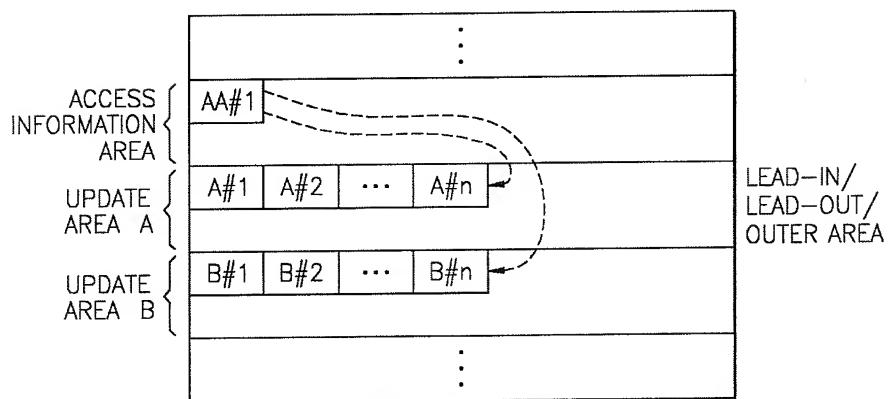


FIG. 5A

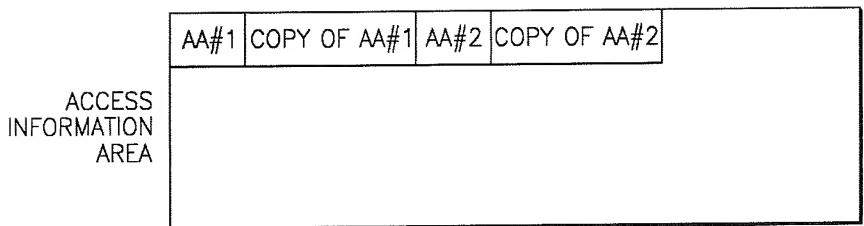


FIG. 5B

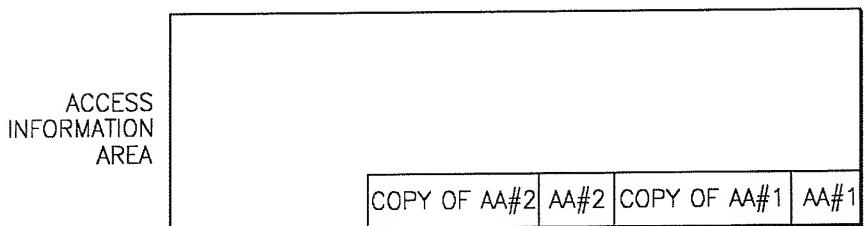


FIG. 5C

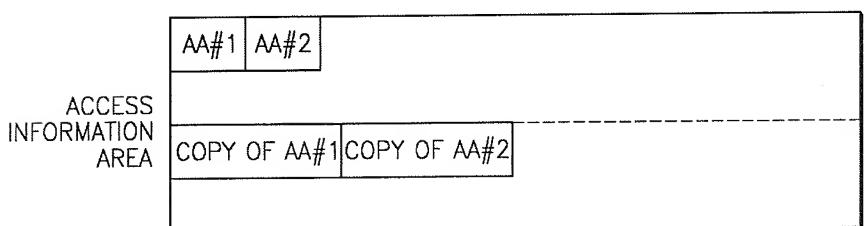


FIG. 5D

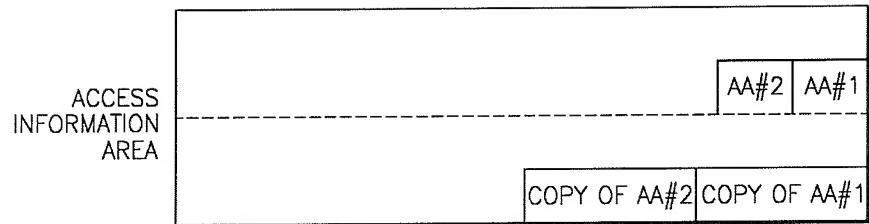


FIG. 6

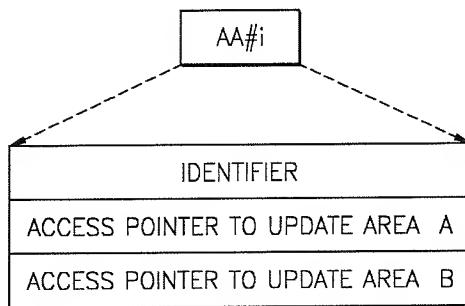


FIG. 7

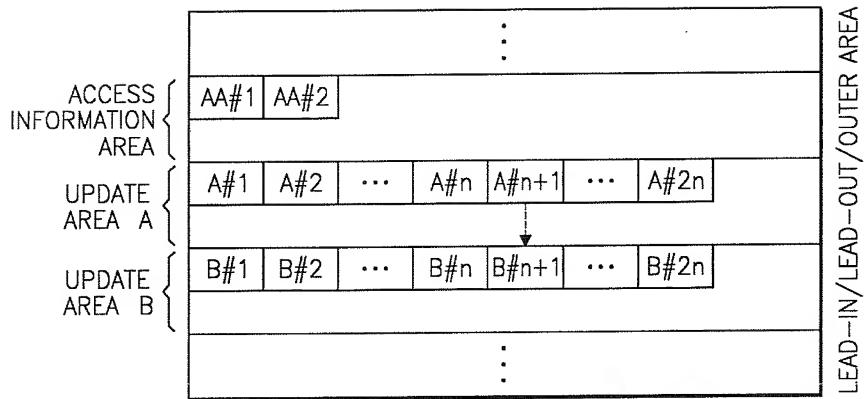


FIG. 8

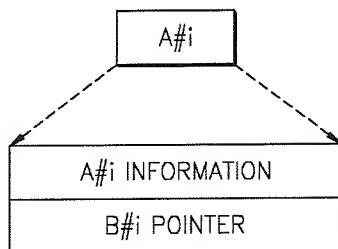


FIG. 9

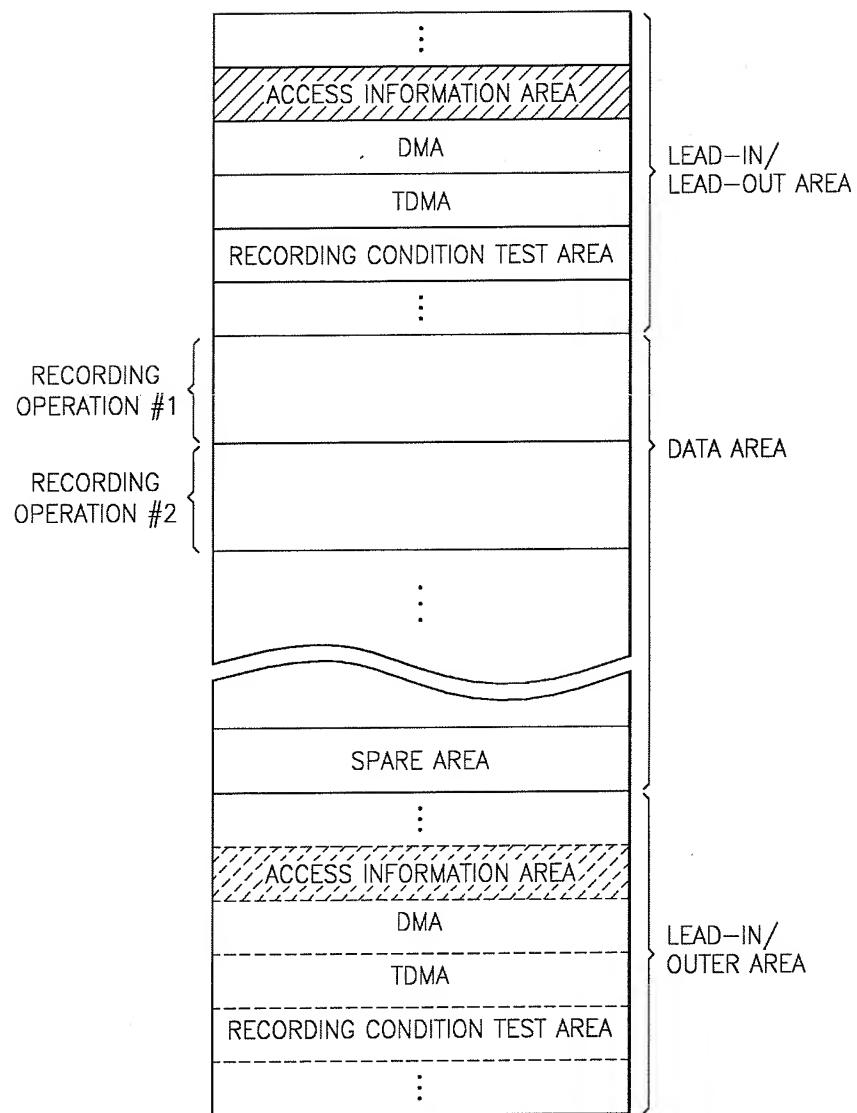


FIG. 10

